Aquaponics in the classroom - integrating STEM education and food literacy training in an elementary school

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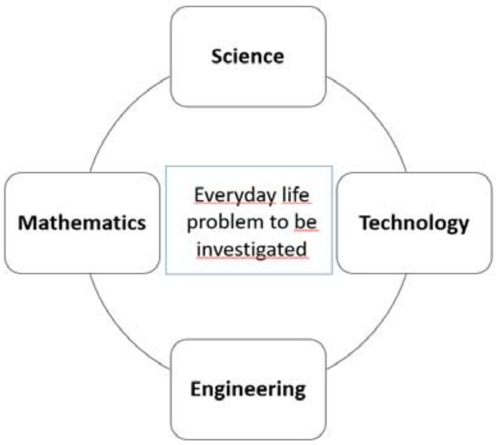
Introduction

Sustainable food production and consumption is of growing societal importance. Growth of populations, scarcity of arable land and urbanization are factors that has led to an increased interest and to new policy actions. Aquaponics is as a closed loop nutrient cycling system measure that can support circular economy and climate-smart farming practices. It has the potential to offer new opportunities as a learning instrument for young people at school. In particular, didactic approaches that builds on the principles of STEM education - Science, Technology, Engineering, Mathematics – are called for (Bybee, 2010). The Growing Blue & Green program (GBG) is an educational framework that incorporates these four disciplines into one meta- discipline as illustrated in figure 1. The aim of this paper is to examine to what extent a low cost GBG system fitted with digital sensors to provide insight into the self-regulatory properties of biological systems could be adapted to the learning environment of a secondary school class. The program was developed to meet the following learning objectives: Students should get insight into acquisition of data for scientific purposes, develop their skills in problem-solving, communication and systems thinking, improve their skills in group based experiental learning as well as develop their skill in solving "wicked" contextual problems related to challenges from today's world, e.g. climate change, health, food production etc.

The main goal of the research was to investigate how the GBG approach could be developed to be part of the curricula, and be integrated in a biology class setting. The potentials of using aquaponics for educational purposes has previously been studied (Graber et al 2014; Junge et al 2014, Bosire et al. 2017). The current study investigates the potentials of including digital based sensor technology. These can be used for measuring water quality including pH, temperature and nitrates and ammonia levels. The complete educational program package was named the eGBG.



Methods

Combining smart and sensor based control and biological system therefore seems straightforward. Urban farming technology requires a monitoring system with a multitude of sensors since maintaining a system in balance requires continuously measuring of temperature, pH, etc. The eGBG was developed in cooperation between the university, a municipal school in Albertslund and a small aquaponics enterprise - Bioteket. The development process was configured as an action research undertaking where data was collected along with the development process. For this paper a simplified version of an aquaponics unit was placed in Herstedlund school in the municipality of Albertslund. The unit had previously been successfully tested at the Blaagaard municipal school. The program ran for 4 weeks in the elementary school, while the students were learning to take care of the system. The daily tasks included feeding the fish, monitoring the growth and health of the plants. During the classes the student were tasked with measuring the quality parameters of the water, such as temperature, pH and nitrate content.

The data-collection was aimed at assessing the feasibility of the eGBG program and included three different kinds of qualitative methods: interviews with the biology teachers, focus group with students as well as observations during biology classes.

Results and conclusion

Insights so far suggest that the sensors provide a useful and convenient tool to incorporate STEM education principles into the Biology curricula at secondary school. The low cost aquaponics system that was developed has the potential to illustrate principles of urban food production and can serve as a tool to develop food literacy and skills and at the same time provide learning about the principles of sensore assisted selfregulation in living biological systems. The findings suggest that automatization of some of the crucial control variables could help in the maintenance of the system.

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References

Bosire, CM, Breidahl, KS, Sikora, TA & Mikkelsen, BE. (2017). Education for sustainability and food literacy - assessing opportunities and challenges for using aquaponics among young people at Schools. In Mikkelsen, BE; Ofei, KT; Tvedebrink, TDO; Romani, AQ & Sudzina, F (eds): Proceedings from 10th International Conference on Culinary Arts and Sciences, July 5-7th 2017 Aalborg University Copenhagen - Exploring Future Foodscapes, Published by Captive Food Studies. AAU, p 250 –

Bybee, RW: Advancing STEM Education (2010). A 2020 VisionTechnology and Engineering Teacher, September

Graber, A., Antenen, N., Junge, R. (2014). 'The multifunctional aquaponic system at ZHAW used as research and training lab. Available at: http://pd.zhaw.ch/publikation/upload/207534.pdf

Junge, R, Wilhelm, S & Hofstetter, U (2014). Aquaponic in classrooms as a tool to promote system thinking''. Available at: http://www.adam- europe.eu/prj/10804/prj/Paper_VIVUSConf_Junge_et_al.pdf (accessed 23 May 2016).